



Sugarcane rusts: how many are out there?

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DNA fingerprinting has shown that close to Australia there are a number of diverse rusts that infect wild sugarcane. These rusts should be considered a quarantine risk until more is known about them.

Until the epidemic of 2000, orange rust had been a minor pathogen and there had been little research into the pathogen and the disease. During the epidemic, the industry had to respond to the outbreak without a full understanding of the pathogen. Since 2000 the orange rust problem has been brought under control, initially by the use of fungicides and then through the adoption of resistant varieties. Dry weather conditions in recent years have helped, but BSES Limited plant pathologists have not been idle during this time. Research has been under way behind the scenes to better understand this disease and thus prevent any new outbreaks.

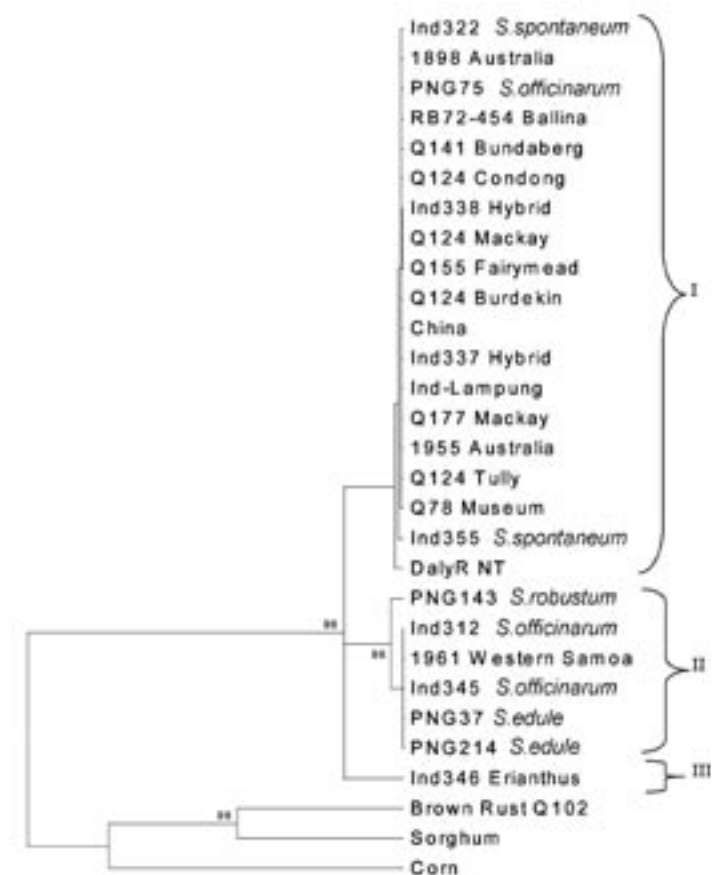
Circumstantial evidence suggested that the 2000 epidemic was due to the appearance of a new race, which

may have developed in Australia or have been introduced from overseas. In an effort to track and identify the source of the supposed new race, the pathologists compared a large collection of orange rust samples from Queensland and NSW fields with samples from Papua New Guinea, Indonesia, China and Western Samoa, as well as historical samples from before the epidemic, stored in a herbarium.

For each rust sample, they determined the DNA sequence from a small part of its genetic material. The DNA sequences from all the rust samples were then compared and the results presented in the form of a 'tree', similar to a family tree, to show which samples are closely related (if the branches are short) or distantly related (if the branches are long). Closely related samples on the same main branch are said to form a cluster. The tree shown in Figure 1 is of a region known as the intergenic spacer of the ribosomal gene.

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Figure 1: The relationship between different rust samples has been determined by DNA sequencing and presented graphically as this tree. The orange rust samples fall into three sub-groups or clusters, but can still be clearly distinguished from brown, corn and sorghum rusts. Australian samples are named after their host and location eg Q141-Bundaberg. There are two historical samples from 1898 and 1955. Overseas samples are given a code indicating the country of origin: Indonesia (e.g. Ind-322), PNG, China and Western Samoa, and host if known.



All Queensland and NSW orange rust samples were found to be very closely related. This suggests that there is only a single dominant variety of orange rust currently present in Australian sugarcane fields.

However, some of the overseas rusts showed up as very different to Australian orange rust, even though they appeared to be orange rust when collected. The DNA fingerprints separated them into three groups, shown in Figure 1 as three clusters on the tree.

All rust samples collected from commercial sugarcane were closely related and are shown on the tree as cluster I. The Australian orange rust samples are in this group, but so are rusts from Indonesia, Papua New Guinea, China and the historical samples. So it appears that Australian orange rust is not unique. The epidemic probably arose from a chance mutation in a single gene in the existing orange rust to produce a new race able to attack Q124 (previously considered resistant).

Several rust samples from wild sugarcane in Indonesia, Papua New Guinea and Western Samoa separated into two other clusters. These rusts appeared similar to 'typical' orange rust, based on symptoms and spore shape, but their DNA is very different (Figures 2 and 3). Any potential disease risks posed by these rusts are unknown at this stage, but they should be considered a significant quarantine threat to the Australian sugar industry.

Orange rusts and brown rust can be distinguished by the shape of the spores, colour, susceptibility of cane varieties etc, and the DNA results support this. Corn rust (*Puccinia sorghi*) and sorghum rust (*Puccinia purpurea*) were included in the experiment for comparison. The tree clearly shows that orange rust, brown rust, corn rust and sorghum rust are all very distinct fungi. Surprisingly, brown rust appears to be more closely related to sorghum rust than it is to orange rust.

The DNA fingerprinting results show that Australian orange rust is currently genetically uniform and stable. However, another race change can not be ruled out. Fortunately, there have been no reports of major outbreaks since the epidemic and the disease has been increasingly managed as new resistant varieties have been deployed to replace Q124. It is important to be alert for any further race changes. In addition, it is essential to continue quarantine vigilance against the introduction of any new rusts into Australia.

Know your rusts

There are two well known rust diseases of sugarcane – orange rust caused by *Puccinia kuehnii* and brown rust caused by *Puccinia melanocephala*. Brown rust was considered the more serious disease since its worldwide spread in the 1970s and, consequently, was known as ‘common’ rust. Orange rust, although present in Australia since the 1880s, was considered a minor disease and confined to the Asia-Pacific region.

Of course, things changed in 2000 when an orange rust epidemic swept through the industry - the ‘rare’ rust became the ‘common’ rust in Australia. So the name was changed to the more descriptive name of brown rust.

The two rusts can be distinguished by spore colour, shape and ornamentation, and pustule colour. Orange rust is prevalent in humid summer conditions, and brown rust occurs more in the spring.

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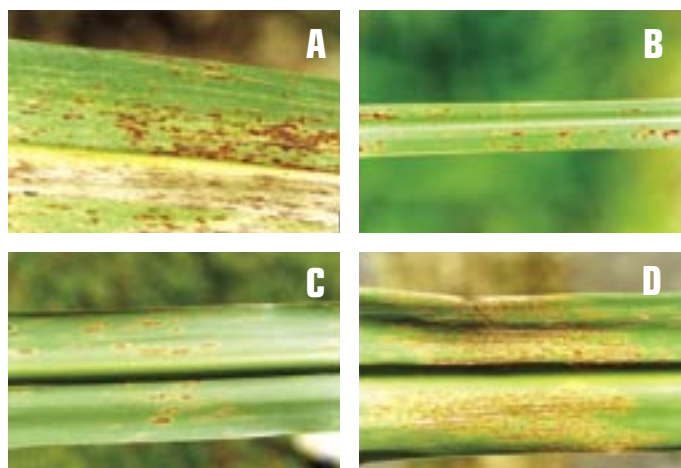


Figure 2: Diverse samples of orange rust from Indonesia show similar symptoms despite DNA fingerprinting showing them to be very different.

- A** Ind-338 (a hybrid cane);
- B** Ind-355 (*S. spontaneum*);
- C** Ind-345 (*S. officinarum*);
- D** Ind-346 (*Erianthus*).

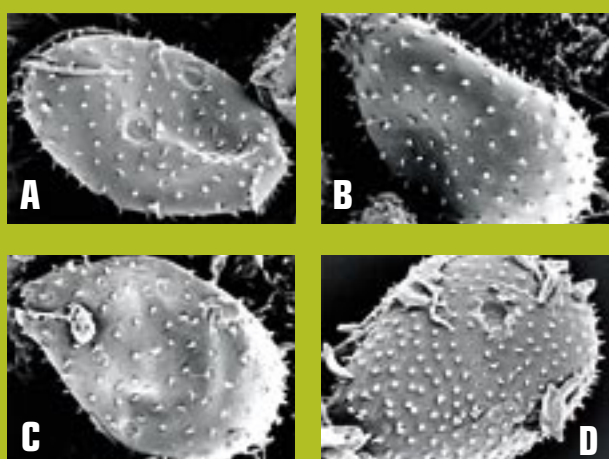


Figure 3: Scanning electron microscope images show that the spores of orange rust samples from Indonesia appear similar despite DNA fingerprinting showing them to be very different.

- A** Ind-337 (from a hybrid cane);
- B** Ind-312 (from *S. officinarum*);
- C** Ind-346 (from *Erianthus*);
- D** brown rust, which is distinguished by the smaller, more numerous spines.